

Technical Description

Gasman II Portable Gas Detector

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System Overview

The GasmanII Portable Gas Detector system is designed to detect the presence of toxic or flammable gases or the absence of life supporting gases. As an option it may be fitted with a low power transmitter PCB to permit the use of a body-worn Vibrating Pager Unit.

The standard GasmanII Portable Gas Detector monitors the level of a particular gas in the atmosphere and provides both an audible and a visual alarm should the gas levels become unacceptable. When fitted with the optional low power transmitter PCB the unit also emits a 418MHz RF carrier wave that is 'On-Off-Key' (OOK) modulated at about 10Hz. It is this signal, which is only emitted while the alarm condition exists, that the GasmanII Vibrating Pager Unit intercepts and produce a pulsing vibration to augment the audible and visual alarms provided by the GasmanII Portable Gas Detector.

Gasman II Block Diagram

The circuit consists of the functional blocks as shown in Figure 1 below and a complete unit is assembled from 3 PCBs, with an optional fourth PCB, as shown in the appendices. Each of the three distinct gas types requires a specific type of gas sensor, signal conditioning circuitry and calibration information. All of the gas sensors share a similar mechanical design and are plugged into a small daughter board at the top of the unit. The output signal from the various types of sensor is different and each requires a corresponding signal conditioning amplifier to interface the signal to the common CPU section. The calibration information is stored in non-volatile memory within the unit and is factory set.

The CPU is powered in a low-power state at all times that batteries are present and controls the electronic switch to apply power to the rest of the circuitry when one of the front-panel mounted buttons is pressed. Once powered the unit continuously monitors the gas level comparing it with preset alarm levels and, should an alarm level be exceeded, the buzzer and the LED operate to provide both audible and visual warnings. The two signals that drive the LEDs are combined on the optional low-power transmitter PCB to form a 10Hz signal that is used to modulate an RF Monolithics transmitter module.

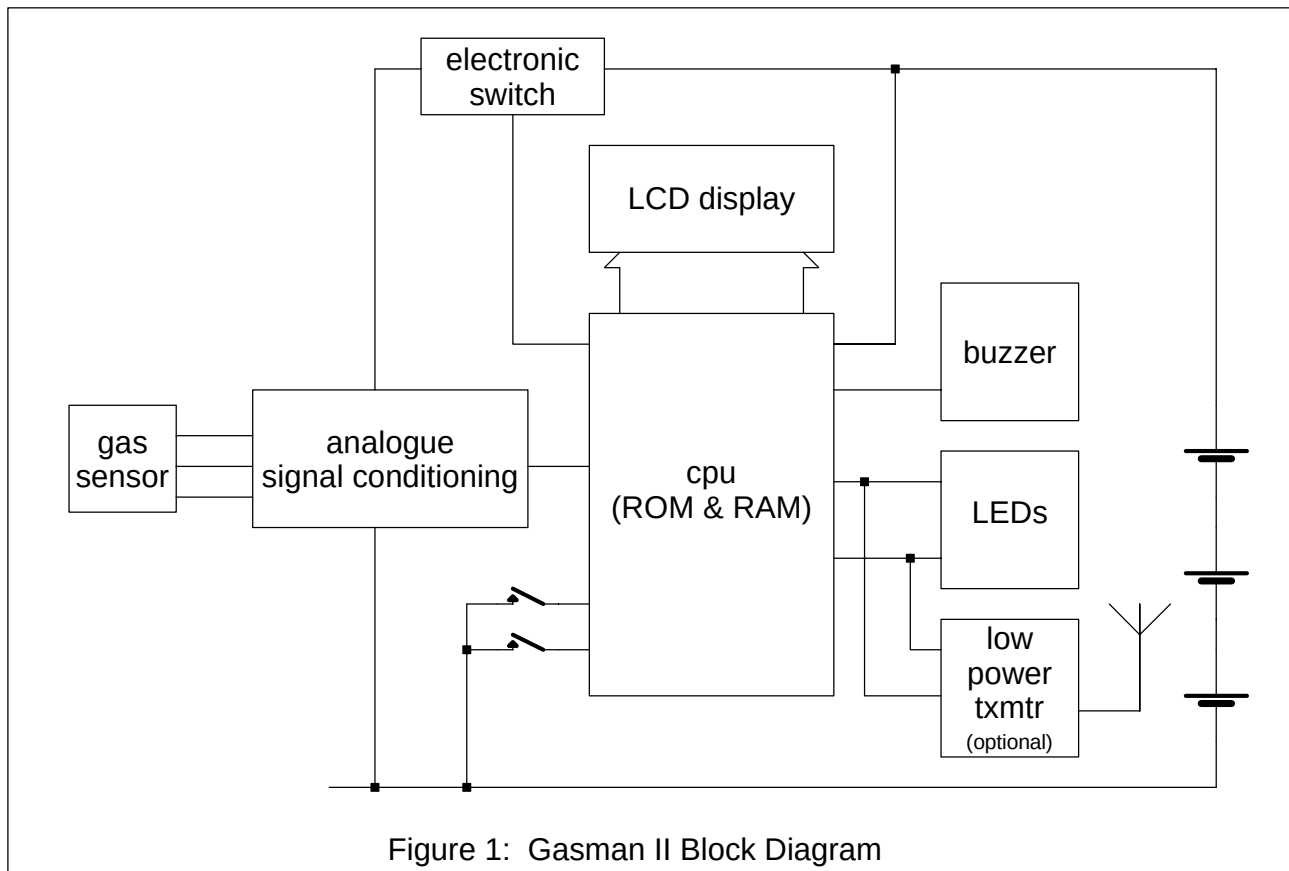


Figure 1: Gasman II Block Diagram

Gasman II Circuit Description

The following description of the circuit refers to the schematics shown in Appendix A.

Sheet 1 (CPU/Display PCB)

The CPU is at the heart of the unit and contains the operating program stored in OTPROM and a quantity of RAM for general variable storage. Q1A and IC3 provide the electronic switch shown in the Block Diagram above and these two components form a switched +3V supply that is used to power various circuit sections. IC2 is an EEPROM and is used to store data relating to configuration and calibration while IC4 provides a CPU reset/watchdog function. Under the control of one of the CPU I/O lines Q1B is used to switch the LCD backlight on and off. S1 and S2, the two user push-buttons, are used to control the units function. Two crystals, X1 and X2, provide the clock signal for the CPU with X1, at 2.51MHz, providing the frequency for normal operation and X2, at approximately 32kHz, providing the clock signal for the CPU when not in full operation. The connections to the Main PCB are made through connectors J1 and J2 with JP4 providing the connection to the optional low-power transmitter PCB.

Sheet 2 (Main PCB) - Toxic

This PCB contains the 3 batteries used to provide power to the unit, the analogue signal conditioning for the gas sensor and also the 'buffers' for driving the buzzer and the LEDs.

IC2 provides the necessary amplification and level shifting to enable the output from the gas sensor to be coupled to the CPU ADC input. The unit is configured using a custom PC application and communication is accomplished via connector J4. IC3 (comparator) is used to extract the data sent by the PC from the common 'signal' wire and Q2 is used to impress the data sent by the Gasman II to the PC onto the 'signal' wire. Varistor, RV1, provides protection against ESD transients. IC3 (op-amp) provides a control loop for powering the sensor and is arranged to maintain constant operating conditions. Header, H1, is a small plug-in PCB containing resistors that set the offset and gain of the sensor signal conditioning amplifier. IC1(A/B) is used to provide a boosted drive signal during an alarm condition for the buzzer and two LEDs. IC1B is wired to provide a differential drive to the buzzer and thus generates a greater sound level. IC1A provides the drive to the LEDs and also the drive to Q2 as mentioned above. Q1 is a depletion-mode FET, i.e. its channel conducts until biased off, which is used to short the sensor terminals when the unit is switched off. The connections to the CPU/Display PCB are made through connectors J1 and J2 while J3 provides the connection to the Sensor PCB.

Sheet 2 (Main PCB) - Flammable

This PCB contains the 3 batteries, NiCAD types, used to provide power to the unit, the analogue signal conditioning for the gas sensor and also the 'buffers' for driving the buzzer and the LEDs. An additional function fitted to the PCB is the ability to charge the NiCAD batteries.

IC5 and IC2 provide the necessary amplification and level shifting to enable the output from the gas sensor to be coupled to the CPU ADC input. The CPU provides a method of 'auto-zeroing' the output from the sensor by providing a variable M/S ratio PWM signal to the base of Q3. The effect of this, once smoothed by R4 and C5, is to provide a variable 'calibration voltage' at TP3. FET, Q4, is used to change the gain of the signal-conditioning amplifier under CPU control.

The unit is configured using a custom PC application and communication is accomplished via connector J4 and varistor, RV1, provides protection against ESD transients. IC3 in conjunction with FET, Q1, provide a low battery protection system and remove power to the PCB when the battery voltage falls below about 2.3V. IC4, in conjunction with FET, Q2, provide a power supply to the sensor that may be turned off by the CPU to save battery power. IC1(A/B) is used to provide a boosted drive signal during an alarm condition for the buzzer and two LEDs. IC1B is wired to provide a differential drive to the buzzer and thus generates a greater sound level. IC1A provides the drive to the LEDs and also provides the transmit-data signal to the PC over the communications link. The connections to the CPU/Display PCB are made through connectors J1 and J2 while J3 provides the connection to the Sensor PCB.

Sheet 2 (Main PCB) - Oxygen

This PCB contains the 3 batteries used to provide power to the unit, the analogue signal conditioning for the gas sensor and also the 'buffers' for driving the buzzer and the LEDs. An additional function is the provision of an NTC thermistor to permit the ambient temperature to be monitored.

IC2 provides the necessary amplification and level shifting to enable the output from the gas sensor to be coupled to the CPU ADC input. The unit is configured using a custom PC application and communication is accomplished via connector J4. IC3 is used to extract the data sent by the PC from the common 'signal' wire and Q2 is used to impress the data sent by the Gasman II to the PC onto the 'signal' wire. Varistor, VR2, provides protection against ESD transients. IC1(A/B) is used to provide a boosted drive signal during an alarm condition for the buzzer and two LEDs. IC1B is wired to provide a differential drive to the buzzer and thus generates a greater sound level. IC1A provides the drive to the LEDs and also the drive to Q2 as mentioned above. Q1A and TH1 provide the ambient temperature monitoring capability with the voltage across the thermistor being fed to a CPU ADC input. The connections to the CPU/Display PCB are made through connectors J1 and J2 while J3 provides the connection to the Sensor PCB.

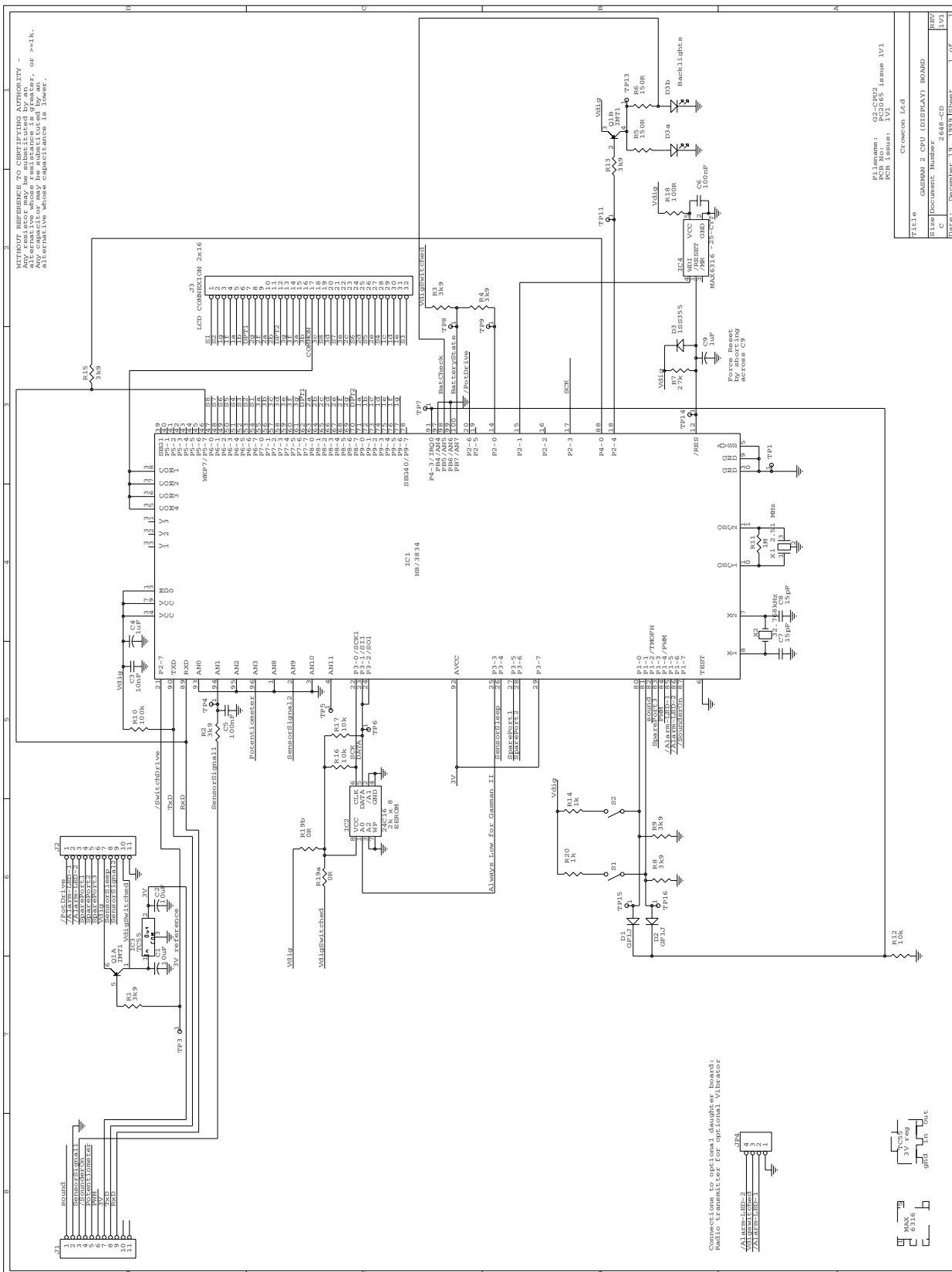
Sheet 3 (Sensor PCB)

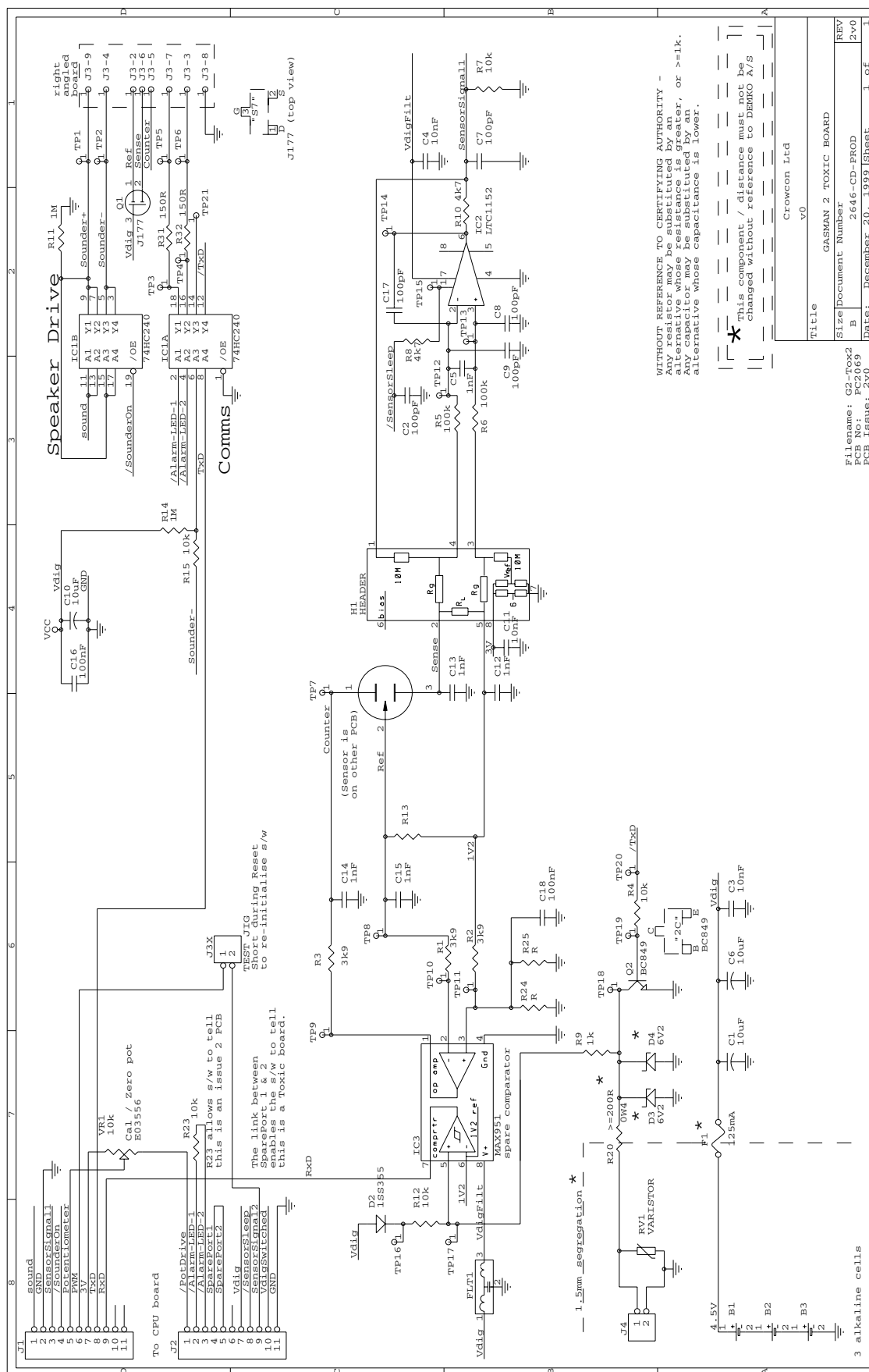
This is a simple PCB that plugs into the Main PCB via connector J1. It contains the buzzer and the two LEDs along with two sites for a gas sensor. The two sites are necessary to accommodate the two slightly different physical shapes of the gas sensors and are overlaid so as to position each of the gas sensor types in the same place when fitted.

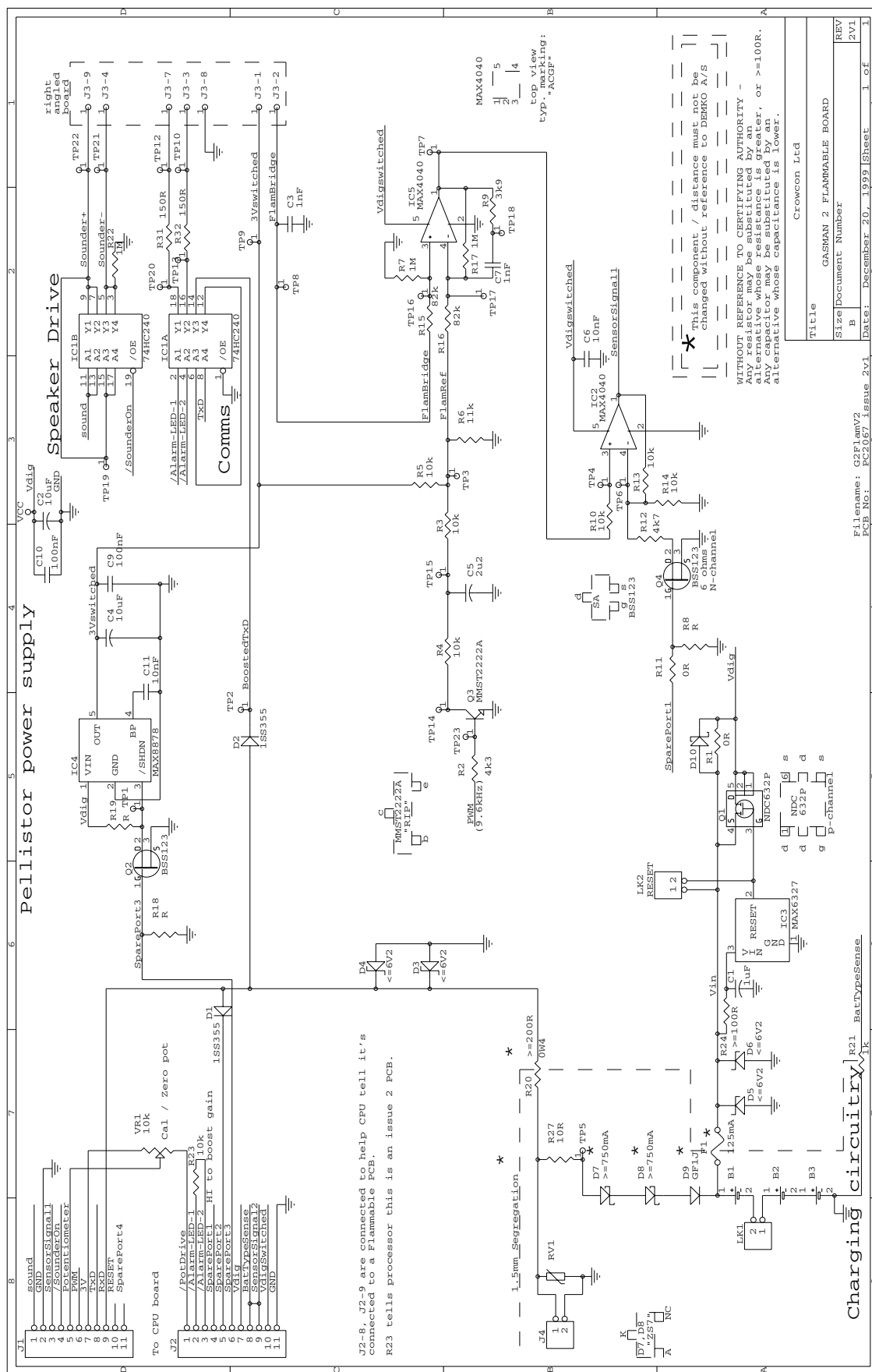
Sheet 4 (Optional Low-Power Transmitter PCB)

This simple PCB plugs into the CPU/Display PCB via J1 which carries both power and the two LED control signals. The LED control signals are 'ORed' together on this PCB to provide a 10Hz modulation waveform. This waveform is used to power the transmitter module, IC1, using FETs Q1 and Q2.

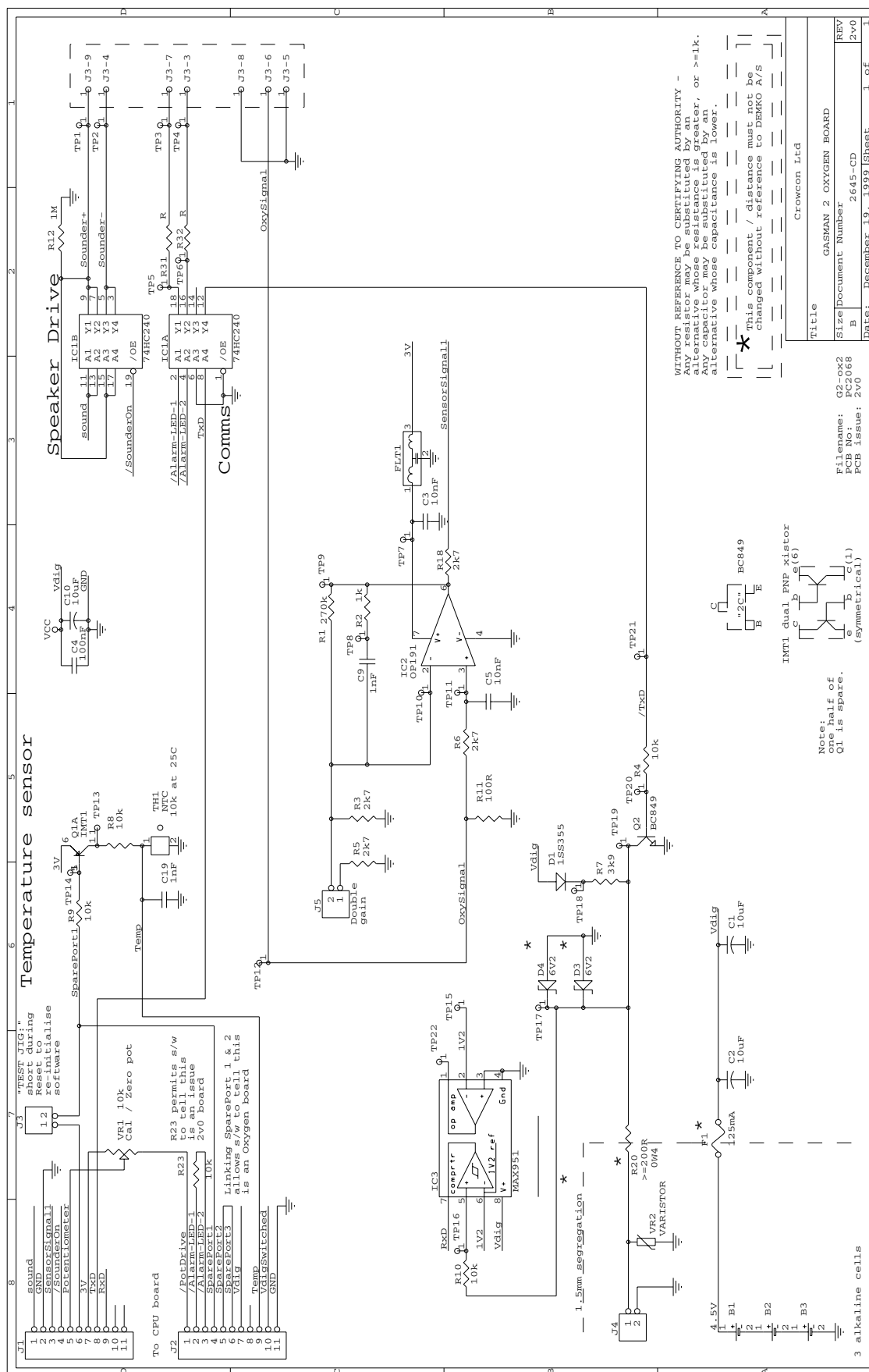
Appendix A - Schematic Diagram (Sheet 1)

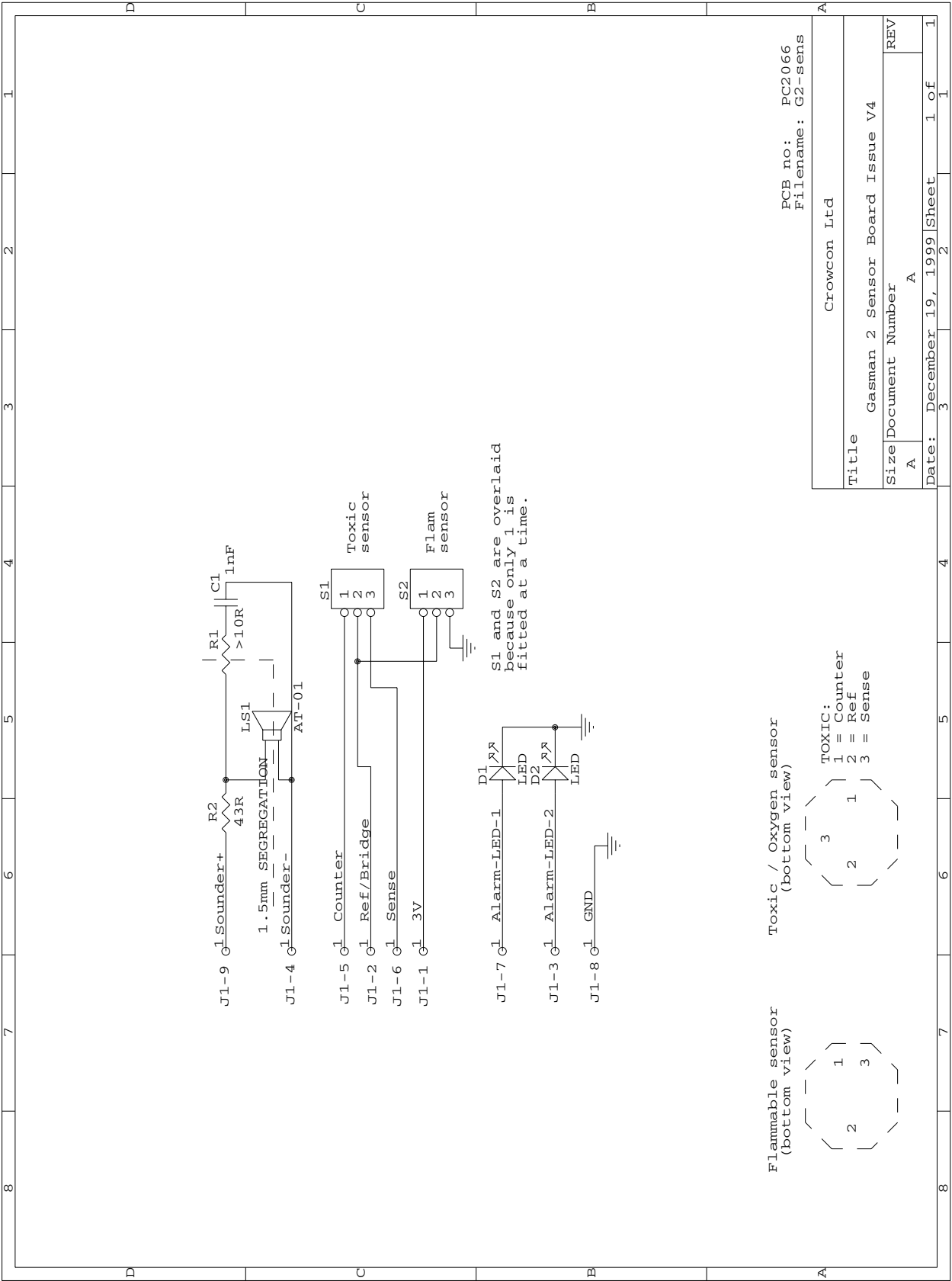


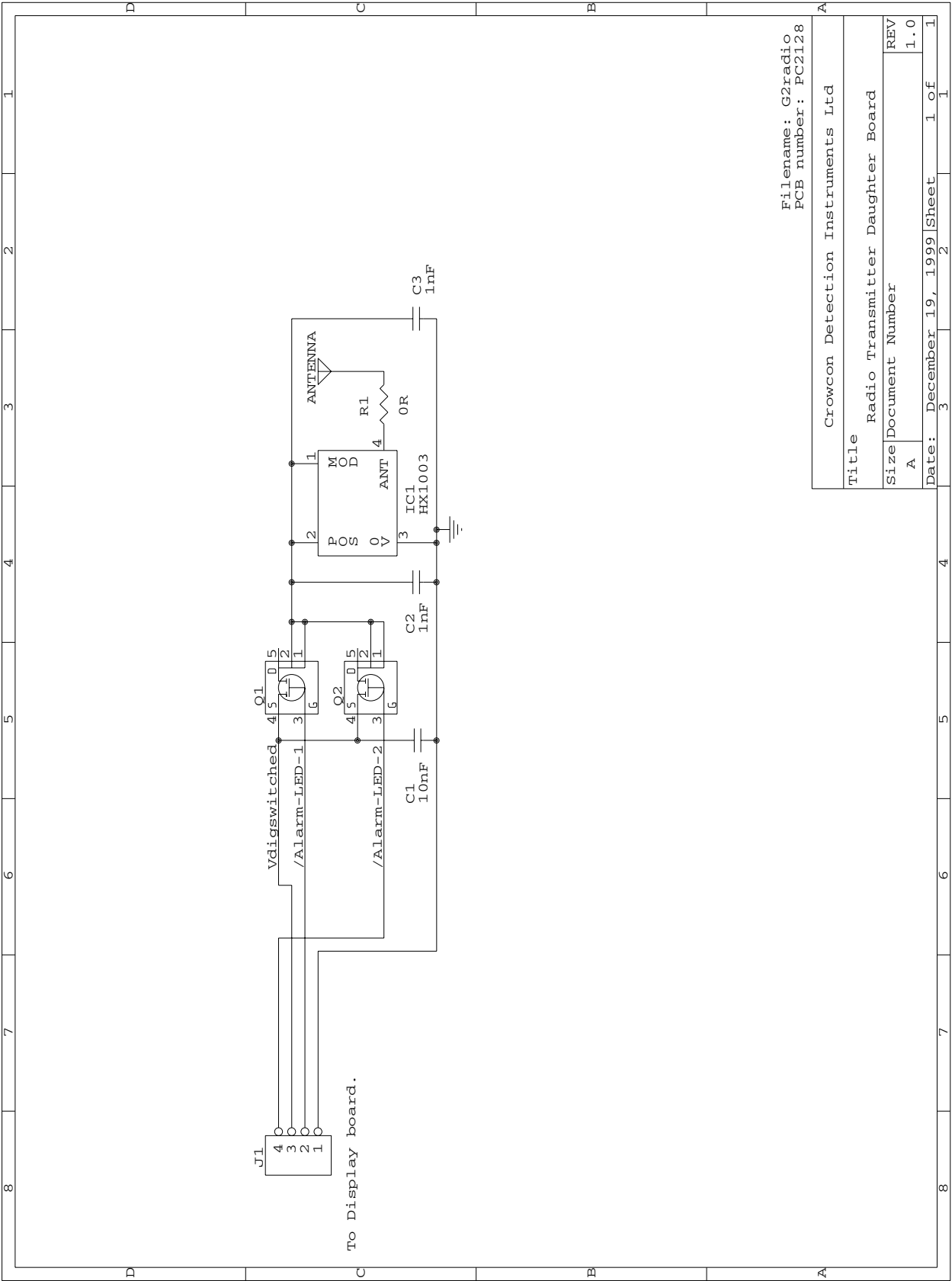




Appendix A - Schematic Diagram (Sheet 2) - Oxygen







Appendix B - Parts List (Sheet 1)

This appendix gives the parts list for the GasmanII Portable Gas Detector CPU/display PCB. For each circuit reference a description of the component is given and, where appropriate, its case style is listed.

Circuit Ref.	Component Description	Case Style
C1	10uF 16V Tantalum	Case A
C2	10uF 16V Tantalum	Case A
C3	10nF 25V X7R Multi-layer Ceramic	0805
C4	1uF 16V Tantalum	Case A
C5	100nF 16V X7R Multi-layer Ceramic	0805
C6	100nF 16V X7R Multi-layer Ceramic	0805
C7	15pF 25V COG Multi-layer Ceramic	0805
C8	15pF 25V COG Multi-layer Ceramic	0805
C9	1uF 16V Tantalum	Case A
D1	GF1J	SMA
D2	GF1J	SMA
D3	1SS355	SOD123
IC1	Motorola H8/3834	100PQFP
IC2	Microchip 24C16	SO8
IC3	TC55 3V Regulator	SOT89
IC4	MAX6316	SO8
Q1	IMT1	SOT23-6
R1	3k9 0.25W 2% 200ppm Nickel Barrier Resistor	1206
R2	3k9 0.25W 2% 200ppm Nickel Barrier Resistor	1206
R3	3k9 0.25W 2% 200ppm Nickel Barrier Resistor	1206
R4	3k9 0.25W 2% 200ppm Nickel Barrier Resistor	1206
R5	150R 0.4W 2% 200ppm Nickel Barrier Resistor	1210
R6	150R 0.4W 2% 200ppm Nickel Barrier Resistor	1210
R7	27k 0.25W 2% 200ppm Nickel Barrier Resistor	1206
R8	3k9 0.25W 2% 200ppm Nickel Barrier Resistor	1206
R9	3k9 0.25W 2% 200ppm Nickel Barrier Resistor	1206
R10	100k 0.25W 2% 200ppm Nickel Barrier Resistor	1206
R11	1M 0.25W 2% 200ppm Nickel Barrier Resistor	1206
R13	3k9 0.25W 2% 200ppm Nickel Barrier Resistor	1206
R14	1k 0.25W 2% 200ppm Nickel Barrier Resistor	1206
R15	3k9 0.25W 2% 200ppm Nickel Barrier Resistor	1206
R16	10k 0.25W 2% 200ppm Nickel Barrier Resistor	1206
R17	10k 0.25W 2% 200ppm Nickel Barrier Resistor	1206
R18	100R 0.25W 2% 200ppm Nickel Barrier Resistor	1206
R20	1k 0.25W 2% 200ppm Nickel Barrier Resistor	1206
S1	Push Switch Omron B3S-1000	N/A
S1	Push Switch Omron B3S-1000	N/A
X1	2.51MHz Crystal	N/A
X2	32.768kHz Crystal	N/A

Appendix B - Parts List (Sheet 2) - Toxic

This appendix gives the parts list for the GasmanII Portable Gas Detector Main PCB - Toxic version. For each circuit reference a description of the component is given and, where appropriate, its case style is listed.

Circuit Ref.	Component Description	Case Style
C1	10uF 16V Tantalum	Case B
C2	100pF 25V COG Multi-layer Ceramic	0805
C3	10nF 25V X7R Multi-layer Ceramic	0805
C4	10nF 25V X7R Multi-layer Ceramic	0805
C5	1nF 25V X7R Multi-layer Ceramic	0805
C7	100pF 25V COG Multi-layer Ceramic	0805
C8	100pF 25V COG Multi-layer Ceramic	0805
C9	100pF 25V COG Multi-layer Ceramic	0805
C10	10uF 16V Tantalum	Case B
C11	10nF 25V X7R Multi-layer Ceramic	0805
C12	1nF 25V X7R Multi-layer Ceramic	0805
C13	1nF 25V X7R Multi-layer Ceramic	0805
C14	1nF 25V X7R Multi-layer Ceramic	0805
C15	1nF 25V X7R Multi-layer Ceramic	0805
C16	100nF 16V X7R Multi-layer Ceramic	0805
C17	100pF 25V COG Multi-layer Ceramic	0805
C18	100nF 16V X7R Multi-layer Ceramic	0805
D1	1SS355	SOD123
D3	6V2 1.3W Zener Diode	MELF
D4	6V2 1.3W Zener Diode	MELF
F1	125mA	N/A
FLT1	Supply Line Filter	N/A
IC1	74HC240	SSOP20
IC2	LTC1152	SO8
IC3	MAX951	SO8
Q1	J177	SOT23-6
Q2	BC849	SOT23
R1	3k9 0.25W 2% 200ppm Nickel Barrier Resistor	1206
R2	3k9 0.25W 2% 200ppm Nickel Barrier Resistor	1206
R3	3k9 0.25W 2% 200ppm Nickel Barrier Resistor	1206
R4	10k 0.25W 2% 200ppm Nickel Barrier Resistor	1206
R5	100k 0.25W 2% 200ppm Nickel Barrier Resistor	1206
R6	100k 0.25W 2% 200ppm Nickel Barrier Resistor	1206
R7	10k 0.25W 2% 200ppm Nickel Barrier Resistor	1206
R8	4k7 0.25W 2% 200ppm Nickel Barrier Resistor	1206
R9	1k 0.25W 2% 200ppm Nickel Barrier Resistor	1206
R10	4k7 0.25W 2% 200ppm Nickel Barrier Resistor	1206
R11	1M 0.25W 2% 200ppm Nickel Barrier Resistor	1206
R12	10k 0.25W 2% 200ppm Nickel Barrier Resistor	1206
R14	1M 0.25W 2% 200ppm Nickel Barrier Resistor	1206
R15	10k 0.25W 2% 200ppm Nickel Barrier Resistor	1206
R20	330R 0.4W 2% 200ppm Nickel Barrier Resistor	1210
R23	10k 0.25W 2% 200ppm Nickel Barrier Resistor	1206
R24	100k 0.25W 2% 200ppm Nickel Barrier Resistor	1206
R25	510k 0.25W 2% 200ppm Nickel Barrier Resistor	1206
R31	150R 0.4W 2% 200ppm Nickel Barrier Resistor	1210
R32	150R 0.4W 2% 200ppm Nickel Barrier Resistor	1210
RV1	Varistor	1206
VR1	10k 0.1W Preset	N/A

Appendix B - Parts List (Sheet 2) - Flammable

This appendix gives the parts list for the GasmanII Portable Gas Detector Main PCB - Flammable version. For each circuit reference a description of the component is given and, where appropriate, its case style is listed.

Circuit Ref.	Component Description	Case Style
C1	1uF 16V Tantalum	Case B
C2	10uF 16V Tantalum	Case B
C3	1nF 25V X7R Multi-layer Ceramic	0805
C4	10nF 25V X7R Multi-layer Ceramic	0805
C5	2u2F 16V Tantalum	Case B
C6	10nF 25V X7R Multi-layer Ceramic	0805
C7	1nF 25V X7R Multi-layer Ceramic	0805
C9	100nF 16V X7R Multi-layer Ceramic	0805
C10	100nF 16V X7R Multi-layer Ceramic	0805
C11	10nF 25V X7R Multi-layer Ceramic	0805
D1	1SS355	SOD123
D2	1SS355	SOD123
D3	6V2 1.3W Zener Diode	MELF
D4	6V2 1.3W Zener Diode	MELF
D5	6V2 1.3W Zener Diode	MELF
D6	6V2 1.3W Zener Diode	MELF
D7	ZHCS750	SOT23
D8	ZHCS750	SOT23
D9	GF1J	SMA
F1	125mA	N/A
IC1	74HC240	SSOP20
IC2	MAX4040	SOT23-5
IC3	MAX6327	SOT23
IC4	MAX8878	SOT23-5
IC5	MAX4040	SOT23-5
Q1	NDC632P	SOT23-6
Q2	BSS123	SOT23
Q3	MMST2222A	SOT23
Q4	BSS123	SOT23
R2	4k3 0.25W 2% 200ppm Nickel Barrier Resistor	1206
R3	10k 0.25W 2% 200ppm Nickel Barrier Resistor	1206
R4	10k 0.25W 2% 200ppm Nickel Barrier Resistor	1206
R5	10k 0.25W 2% 200ppm Nickel Barrier Resistor	1206
R6	11k 0.25W 2% 200ppm Nickel Barrier Resistor	1206
R7	1M 0.25W 2% 200ppm Nickel Barrier Resistor	1206
R9	3k9 0.25W 2% 200ppm Nickel Barrier Resistor	1206
R10	10k 0.25W 2% 200ppm Nickel Barrier Resistor	1206
R11	0R 0.25W 2% 200ppm Nickel Barrier Resistor	1206
R12	4k7 0.25W 2% 200ppm Nickel Barrier Resistor	1206
R13	10k 0.25W 2% 200ppm Nickel Barrier Resistor	1206
R14	10k 0.25W 2% 200ppm Nickel Barrier Resistor	1206
R15	82k 0.25W 2% 200ppm Nickel Barrier Resistor	1206
R16	82k 0.25W 2% 200ppm Nickel Barrier Resistor	1206
R17	1M 0.25W 2% 200ppm Nickel Barrier Resistor	1206
R19	4k7 0.25W 2% 200ppm Nickel Barrier Resistor	1206
R20	330R 0.4W 2% 200ppm Nickel Barrier Resistor	1210
R21	1k 0.25W 2% 200ppm Nickel Barrier Resistor	1206
R22	1M 0.25W 2% 200ppm Nickel Barrier Resistor	1206
R23	10k 0.25W 2% 200ppm Nickel Barrier Resistor	1206
R24	150R 0.4W 2% 200ppm Nickel Barrier Resistor	1210
R27	10R 0.4W 2% 200ppm Nickel Barrier Resistor	1210

R31	150R 0.4W 2% 200ppm Nickel Barrier Resistor	1210
R32	150R 0.4W 2% 200ppm Nickel Barrier Resistor	1210
VR1	10k 0.1W Preset	N/A
VR2	Varistor	1206

Appendix B - Parts List (Sheet 2) - Oxygen

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This appendix gives the parts list for the GasmanII Portable Gas Detector Main PCB - Oxygen version. For each circuit reference a description of the component is given and, where appropriate, its case style is listed.

Circuit Ref.	Component Description	Case Style
C1	10uF 16V Tantalum	Case B
C2	10uF 16V Tantalum	Case B
C3	10nF 25V X7R Multi-layer Ceramic	0805
C4	100nF 16V X7R Multi-layer Ceramic	0805
C5	10nF 25V X7R Multi-layer Ceramic	0805
C9	1nF 25V X7R Multi-layer Ceramic	0805
C10	10uF 16V Tantalum	Case B
C19	1nF 25V X7R Multi-layer Ceramic	0805
D1	1SS355	SOD123
D3	6V2 1.3W Zener Diode	MELF
D4	6V2 1.3W Zener Diode	MELF
F1	125mA	N/A
FLT1	Supply Line Filter	N/A
IC1	74HC240	SSOP20
IC2	OP191	SO8
IC3	MAX951	SO8
Q1	IMT1	SOT23-6
Q2	BC849	SOT23
R1	270k 0.25W 2% 200ppm Nickel Barrier Resistor	1206
R2	1k 0.25W 2% 200ppm Nickel Barrier Resistor	1206
R3	2k7 0.25W 2% 200ppm Nickel Barrier Resistor	1206
R4	10k 0.25W 2% 200ppm Nickel Barrier Resistor	1206
R5	2k7 0.25W 2% 200ppm Nickel Barrier Resistor	1206
R6	2k7 0.25W 2% 200ppm Nickel Barrier Resistor	1206
R7	3k9 0.25W 2% 200ppm Nickel Barrier Resistor	1206
R8	10k 0.25W 2% 200ppm Nickel Barrier Resistor	1206
R9	10k 0.25W 2% 200ppm Nickel Barrier Resistor	1206
R10	10k 0.25W 2% 200ppm Nickel Barrier Resistor	1206
R11	100R 0.25W 2% 200ppm Nickel Barrier Resistor	1206
R12	1M 0.25W 2% 200ppm Nickel Barrier Resistor	1206
R18	2k7 0.25W 2% 200ppm Nickel Barrier Resistor	1206
R20	330R 0.4W 2% 200ppm Nickel Barrier Resistor	1210
R23	10k 0.25W 2% 200ppm Nickel Barrier Resistor	1206
R31	150R 0.4W 2% 200ppm Nickel Barrier Resistor	1210
R32	150R 0.4W 2% 200ppm Nickel Barrier Resistor	1210
TH1	NTC Thermistor	Bead
VR1	10k 0.1W Preset	N/A
VR2	Varistor	1206

Appendix B - Parts List (Sheet 3)

This appendix gives the parts list for the GasmanII Portable Gas Detector Sensor PCB. For each circuit reference a description of the component is given and, where appropriate, its case style is listed.

Circuit Ref.	Component Description	Case Style
C1	1nF 25V X7R Multi-layer Ceramic	1206
D1	High Brightness LED	T1.75
D2	High Brightness LED	T1.75
LS1	AT-01 Buzzer	N/A
R1	47R 0.5W 5% 200ppm Metal Film Resistor	N/A
R2	47R 0.5W 5% 200ppm Metal Film Resistor	N/A

Appendix B - Parts List (Sheet 4)

This appendix gives the parts list for the GasmanII Portable Gas Detector Low-Power Transmitter PCB. For each circuit reference a description of the component is given and, where appropriate, its case style is listed.

Circuit Ref.	Component Description	Case Style
C1	10nF 25V X7R Multi-layer Ceramic	1206
C2	1nF 25V X7R Multi-layer Ceramic	0805
C3	1nF 25V X7R Multi-layer Ceramic	0805
IC1	HX1003 Transmitter Module	SM-04
Q1	BSS284 MOSFET	SOT23-6
Q2	BSS284 MOSFET	SOT23-6